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AUTHOR Veir, Carole
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ABSTRACT

To provide for the reawakening of students' interest in careers involving science and mathematics, motivation must be fostered within the lower elementary grades through competent mathematics instruction within well-designed school mathematics programs. The focus of this workshop was both on the efficient and effective implementation, within individual classrooms, of the Curriculum and Evaluation Standards as promulgated by the National Council of Teachers of Mathematics, and on the prospective relationship of those standards toward classroom evaluation instruments mandated for use by the Texas Teacher Appraisal System (TTAS). This document contains the transcription of an audiotape of a 3-day inservice teacher workshop presentation, along with all of the workshop handouts and copies of the transparencies used by the presenters during the workshop, as designed and conducted by the TTAS. (JJK)

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# *TEACHER APPRAISAL AND MATHEMATICS:*

## AN INSERVICE DESIGNED FOR THE TEXAS TEACHER APPRAISAL SYSTEM

CAROLE VEIR, ED.D.
THE UNIVERSITY OF TEXAS AT AUSTIN

U.S. DEPARTMENT OF EDUCATION
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DAY ONE

OPENING STATEMENT

I would like to open this workshop today by thanking everyone for being here. I'm really pleased that I have the opportunity to present this workshop tc you. As you know, the focus of this workshop is on math; but it is also intended to focus on math as it relates to the T.T.A.S. instrument. I am sure that there is not one person here who is not highly concerned about the T.T.A.S. instrument.

What I am going to attempt to do in this workshop is to give you an overview, not only of how you can improve your math program, but also how you can incorporate that improvement in what will eventually be your T.T.A.S. evaluation. As everyone knows, T.T.A.S. evaluations for the 1990-1991 school year will all be scheduled. I think this affords all teachers the opportunity to prepare particularly for that lesson for which they will be observed. It gives you the opportunity to present "the" perfect lesson!

With that in mind, our focus here today is, like I said before, math and T.T.A.S. How can we improve math? How can we incorporate those improvements into a T.T.A.S. lesson by being able to focus on all of the indicators in the most effective and efficient manner?

INTRODUCTION

I have prepared a packet of handouts for you. Included in the packet which you have on your desk are the transparencies that I will be going over with you. But, before I move into the transparencies that we are going to be looking at and discussing more thoroughly, I would like to walk you through some of the pages on the handouts. Not only will this serve as an introduction to our workshop, but more than anything else it also will serve to elucidate the fact that math today is really one of our shortcomings as far as our instructional curricula are concerned.

If you look at the first page of your handout packet, entitled "Math in the Job Market", you will notice that there is a minimum amount of math that is required to do jobs that may have one time been considered non-skilled labor, such as a construction worker, an office clerk, and a fire fighter. You now need at least two years of high school math which begins with one year of algebra to hold these positions. Looking further down the list you will note that at least three years of high school math beginning with one year of algebra are required to work as a horticuluralist, a mental health worker, a photographer, or a pharmacy assistant; and going down the list, we see that four years of high school math beginning with two years of algebra, one of geometry and a year of pre-calculus math are required to work as a dentist, an interior designer, a biochemist, an architect, a geologist, and as the numerous other

employments listed there.

I think it is safe to say many present day jobs require a background in numerical and statistical data (Transparency #1). Yet it is becoming increasingly difficult to persuade high school students, especially women, to major in math, science or engineering once they embark upon a college education. In fact, a study conducted by the National Science Foundation concluded that the number of students graduating from high school and entering college even with substantially high math backgrounds is decreasing and in fact, it has decreased significantly from year to year. Nonetheless, the United States will require a substantial number of people in these fields to be able to maintain its competitive edge on the world market in the future.

Therefore, if we are going to reawaken the interest of students in the science and math areas, we will have to motivate them beginning in the lower grades. In order to do this we need to have competent math teachers and well designed math programs. As students reach the last few years of their secondary education they realize that it is important to be able to have a job that is going to provide them with some substantial monetary compensation. But it is never too early to begin to instill in our student population the importance of math and sciences.

As you look at Handout #2 (Transparency #2) in the packet you will see that the best jobs in America relate to math professions; the top 8 are almost totally math oriented. As we look at these top 8 jobs that are listed beginning with no. 1 on

down to no. 8 one can note the high degree of math required to be able to compete in any of these positions. Furthermore, if we look at the top growth occupations between now and the year 2,000 (Handout #3, Transparency #3) you can see that at least three of these occupations would require a great deal of math emphasis and/or a strong math background.

There are numerous careers which involve math that are part of this occupation growth that will occur between now and the year 2,000. In order to be able to provide children with the math career motivation we need to have good math teachers in place from the lowest grade on through the highest in public education.

If we look at our work force in this country by the year 2,000 there are several things that stand out. I will just give you a minute to look at this transparency and to reflect on what it says to you (Handout #4, Transparency #4).

First of all, the income generating assets of a nation are the knowledge and skills of its workers. If we don't have people knowledgeable in their field, who can provide the expertise necessary to compete on the world market, where would we be as a country? At one time a high school education was thought unnecessary for many factory workers. A college degree, a B.A. or a B.S. was thought to be the acme of one's academic necessity in life; the sum total of as much as one could need to aspire to academically. But, in our present day and age all of this is changing and the majority of all new jobs are going to require

some post-secondary education and even the least skilled jobs require a good command of reading and computation skills. Yet at one time these skills were probably necessary only for very advanced professionals.

Finally, the thing which probably touches me the most is the fact that education is really what makes the culture of a nation. Education and training are the primary systems by which the human capital of a nation is preserved and increased. Without education what do we have as a nation? If our future as a country is to be realized in a positive manner, we need to have students in school working harder and being able to aspire to more advanced cognitive tasks than ever before.

I have also included two very important pages in the handout packet (Handouts #5 - 6). The first one deals with the importance of education and of good educational backgrounds for minorities who are entering the work force of the 21st century. It relates not only to the fact that minorities need to be able to compete on the job market of the 21st century, but also that as educators we need to focus on the necessity for educating our minorities well so that they will be able to compete on the job market of the 21st century. Their inability to succeed on the job market will directly impact everyone in our economy.

One of the more controversial issues that relates to minority education involves the drastic and radical modification of the present programs that are in place in many school districts. It calls in certain instances for the privatization of

schools, raising standards for everyone - students, teachers, administrators, and all schools, in general. It's a call for excellence throughout the entire system. It calls for vast reform within the contributions to our social programs from the federal and state government. It also calls for private industry to play a big roll in demanding higher standards from the public school education system.

As the world moves farther into the post-industrial era human capital plays the most important role in the progress of a country. As societies in general are becoming more complex the amount of education and knowledge required to make a productive contribution to society and your country's economy, in general, becomes greater. Although these things may seem very isolated, in reality, they aren't. It is the productivity of our well-qualified work force that provides the necessary leadership in industry, the private, and the public sectors, which in turn allows us to enjoy the quality standard of living that we have had in the past, would like to have in the present, and hope to have in the future as well.

We can no longer look to vocational programs that warehouse students who do poorly in academic areas and are eventually placed in their graduating classes for nothing more than years of school attendance versus true academic achievement. We need to have higher standards in our schools and one of the specific areas on which we need to focus is mathematics because if a bright future is to be realized students must go to school

longer, study more and pass more difficult tests covering more advanced subject matter (Transparency #5). Contemporary technology has seriously impacted our math programs in ways hitherto not imagined and consequently we have to take these ramifications into account (Transparency #6).

In math many people favor the brief introduction of concepts rather than repeated practice. Concepts are important, but to develop the understanding of concepts, it is necessary to practice over and over again and repeat the concept through practice so that it can be integrated through repeated practice. A good performance in math involves getting into what I like to call the "math mode" through that repeated practice and through the eventual application of the concept. Manipulatives suit this purpose perfectly.

Through repeated and varied practice the student can repeat the abstract concept until eventual understanding comes automatically... something "clicks". By repeating math skills, and at the same time applying abstract concepts to concrete math skills, students make math part of their second nature - much the same procedure used in the rote memorization of our ABC's. Although many people do not favor rote memorization in certain areas, particulary in mathematics, I feel there is a very fine line between repeated practice and rote memorization. Certain successes in math cannot be accomplished without rote memorization for a firm foundation allows students to effortlessly refer back to basic facts during the integration of more advanced

abstract concepts.

I think I would also like to point out that I have witnessed math programs in most European schools and found they are very practice oriented. They do provide a very heavily emphasized concept practice program. European schools and European math programs are generally and across the board, much better, more sophisticated and certainly more successful than the math programs we have in the United States at the present time.

We can see the shortcomings of our country's math programs not only presently but in the past with the advent of the launching of Sputnik and the subsequent race for space. President Kennedy and the Federal Government felt so pressed to acquire mathematicians that they recruited abroad for scientists; notably physicists and mathematicians. In fact many of our senior, tenured professors at U.T., Austin in the Physics and Math Departments are products of this immigrant brain import era. Why did the U.S. have to go abroad to recruit these people?

Again, we come to the fact that the main reason is that we were deficient in those areas in the United States. We are still deficient today and although we are presently experiencing a very small increase of enrollment in math and science classes, the standards of expectations in many of these classes is low.

We don't have to go too far to look at the Engineering Department at U.T., Austin. Japanese students who come to the Engineering Department at the University of Texas are at least one year ahead of our students on a comparable academic level.

American students struggle to maintain a satisfactory level of performance during the first year that they are in class with these Japanese immigrant students. However, by the end of the first year they have pretty much caught up to the level of the Japanese students. Another way to look at this situation is: Could it be that the Japanese students have decreased in their academic productivity and is it because our expectations in our college courses are lower than universities in Japan and Europe?

I think it is important for us to be cognizant of our deficiencies. I look back to the early 70's when my husband was enrolled at the University of Texas. He took an English course in the romantics. Six years later his Romantics professor told him that the course would be impossible to teach anymore because students could no longer deal with the rigor of the curriculum. What does this tell us? It is quite clear that the academic productivity of our students has decreased at the university level.

Every year grants and scholarships go begging because (1) many times no one applies for them; but (2) also because in many instances no one meets the academic standards for grant or scholarship eligibility and subsequent endowment. All of this is a rather circuitous way of saying that there are certain instances where we would like to deceive ourselves, but we really can't afford to do that anymore. Technology is such that we live in a global community and we have to compete and function on a global level. Technology has also changed and continues to

change the expectations for our math curricula (Transparency #6).

There are things in our learning institutions which do require genuine attention and analysis. There are certain areas that are, as educators, going to be beyond our control. In many western countries besides the United States not everyone is entitled to a public education from grades K-12. Most countries provide elementary education to everyone but their academic level of performance must be acceptable to allow them to proceed along an academic track into the secondary level versus a technical or vocational track. Thus, unlike us, many western countries are left with the academic cream of the crop to teach at the secondary level.

I don't want to digress intc that area because as public school educators in the United States we have an obligation to teach our students and to ensure that our methods are effective. That is the task which we should set ourselves to complete to the best of our ability. To determine the effectiveness of teaching methods there are various types of processes that are in place; TEAMS, TAAS, and ITBS. The last two reflect the end product of a teacher's effectiveness as a pedagogical agent.

TTAS, which we are all familiar with, is used to measure teacher competencies during the pedagogical process. Math is a subject which is particularly well-tailored to fit the TTAS observation indicators. TTAS is a teacher-focused instrument and math is a subject that is ideal for direct teaching.

By understanding certain elements of TTAS, teachers should

be able to increase evaluation scores. Math is the ideal subject for that and our focus in this workshop will be problem-solving in the TTAS math lesson. If you improve your instruction during your math lessons you increase students' math performance. You can incorporate all of these three things and come full circle: You serve yourself through serving your students who will in turn serve you.

A lot of this sounds like a back to basics math approach, I know, but in many ways I think of this as being similar to the recent philosophy which seeks to debunk the phonics approach to reading. It discourages teaching skills in isolation as a method for teaching reading and promotes more of what we are seeing in the ECRI reading classes. It is a form of repetitious concept integration which allows almost for the rote memorization process of abstract concepts.

One of my teachers told me years ago, when I was in high school, "There are probably a few areas where practice does not make perfect." Off hand, I really can't think of one. It was true in the particular subject area which he was emphasizing, music, and it is probably true for most other areas as well.

Find the learning style approach that suits the student, then provide the practice which will lead to perfection. You can have it in reading. You can have it in math. Don't negate student learning styles. You should emphasize them in repeated practice. You can enhance the student's comprehension of concepts in this way.

I want to close this portion of the workshop with these last points in mind which come from the professional standards for teaching mathematics published by the National Council for Teachers of Mathematics (Handout #7).

1. The goal of teaching mathematics is to help all students develop mathematical power.
2. What students learn is fundamentally connected with how they learn it.
3. All students can learn to think mathematically.
4. Teaching is a complex practice and, hence, not reducible to recipes or prescriptions.

These standards of teaching are the four assumptions upon which the practice of mathematics teaching is based. In your handout packet there is more elaboration on these four points. I will be free to discuss them with you after the workshop, but unfortunately, there are time limits at this point. Feel free to stay and talk afterwards if you would like. If you have any questions I will be happy to answer them.

DAY TWO

VIDEO TAPE (30 MINUTES)

Our video tape this afternoon will provide an introduction to some of the activities that we are going to do later in our session this afternoon. This video tape features Dr. Cathy Seeley Peavler, Director of Mathematics for TEA, talking about the forces for change in mathematics education today.

(TURN ON VIDEO TAPE. AFTER VIDEO, ALLOW FOR BRIEF COMMENTS SESSION).

What we are going to do now is work in groups of three of four people and engage in some problem-solving activities. After your group solves or attempts to solve some problems we are going to reflect on the problems and the reasons why we engaged in these activities and why we chose these particular solutions.

Let's go ahead and look at these five transparencies that I have prepared for you which detail the problems to be solved (Transparencies #7 - 11).

(Teachers work in groups to solve problems = 15 minutes. Circulate and discuss problems and solutions with them during this time).

Now that we have discussed your problems and your solutions,

I think that you can easily see the role of the teacher as the problem solver. You can see the necessity for strategies, of charting things, of working backwards to see how we did things; the different types of problems that we had to solve, the types of activities that we used to solve them; and the organizing of our group in order to solve these problems.

It is important to analyze how you felt as problem solvers:

What were your attitudes towards the actual problems?

What roles did each of you assume as you solved the problems?

How did you manage to work together cooperatively to solve them?

What were the strategies that you used?

Can we label those strategies?

If you were to be evaluated on both the process of solution and the answer, how well would you do?

(DISCUSSION FOLLOWS: Approximately 10 minutes. Close today by asking participants to read over their TTAS instrument before the next meeting. Ask them to reflect on possible ways to integrate problem-solving activities into their daily math curriculum).

## DAY THREE: PROBLEM SOLVING AND THE TEXAS TEACHER APPRAISAL SYSTEM

There are many terms, i.e., lecture, discussion, direct instruction, modeling, discovery, role-playing and problem solving that are used to label various methods of teaching. Most of these terms, however, are variations or sub-categories within one of two general methods or approaches to teaching.

There is exposition or direct instruction in which completed information and generalizations are presented to students in order for them to memorize, understand or apply the information in generalizations. This method usually indicates the teacher lead nature of good expository teaching.

There is discovery teaching in which students are presented with incomplete information and open-ended situations with the goal of having them figure out rules, principles, generalizations or the solutions to problems on their own with teacher guidance. Discovery lessons involve critical or high order thinking processes such as those involved in analysis, synthesis and evaluation. As teachers we need to remember that to provide children with a mathematical foundation for good problem solving, we need to model a positive attitude and provide a variety of problem solving experiences for being a problem solver (Transparency #12).

The direct instruction method of teaching is reflected in much of the Texas Teacher Appraisal instrument as well as in the cycle that matches the effective teaching practices imbedded in the domains criterion indicators of the TTAS. Problem solving in

mathematics is one form of discovery and while problem solving lessons do not conform entirely to the dominant pattern of teaching encouraged by the TTAS, the teaching practices that support problem-solving can be found readily among the indicators in the appraisal instrument. In fact, teachers who use practices that support good problem solving lessons should be able to earn exceptional quality points on several criteria in the instrument.

Each of the domains and criteria indicated below contains performance indicators that should be especially observable during problem-solving lessons in mathematics. We are going to just briefly review these indicators. I would like to emphasize that it is very important for you to encourage your students to participate in problem solving lessons in mathematics because as you are being evaluated these are things that evaluators will be looking for, i.e., the teacher who has their students actively engaged in problem-solving activities. Let's go over these transparencies; read and discuss them as we go along.

(Handouts #8 - 11, Transparencies #13 - 16).

Now that you have had the opportunity to look at these transparencies, we are going to proceed with activities 1-3 in your handout packet which are designed to involve visual problem-solving. As we work through these activities in our groups I would like you to refer to Handouts #8-11 and be particularly conscious of how you are addressing each indicator and how the different activities can provide opportunities for children with

different learning styles to integrate concepts by developing greater problem-solving abilities. I have some manipulatives and if you will help me, we can now get those passed out. I have numbered them by group. Let's go ahead and divide up into our groups to be able to use them.

(After these activities, teachers will discuss the ways in which the different problem-solving activities relate back to the discussed indicators on the TTAS. Rotate among groups so that they can share their thoughts with you).

CLOSURE

As an administrator I have the responsibility to expose you to the things that I feel will facilitate your improvement of the math program. However, there are a few things that you can do individually and that we can do together to provide and enhance attitudes about problem-solving opportunities for teachers, students and parents. There is a checklist (Handout #12) provided as part of your handout packet and if you will turn to that now, you can see that it's a list of ways to help increase participation in mathematics problem-solving involving teachers, students and parents.

There are alot of things that are already in place in the school which you have taken the initiative to implement individually; but, we can never over-emphasize the need to find a way to focus on mathematics. This checklist has been provided as a sup-

plement to help you perhaps expand methods that you already have in use, or maybe to modify your approaches. I would also be very appreciative if you had comments to add to it, if you could write them down and put them in my box. It would be really helpful for me in the future. Also included is an outline (Handout #13) that was given to me by one of the math coordinators in A.I.S.D. regarding what she considers to be an outline for a successful math lesson. I must admit that upon close perusal of this outline I don't see anything that I think really focuses enough on problem-solving activities. However, this is just an outline... a plan. You are free to modify and expand it at your will. I am just including it as a very basic outline.

I have also checked out some videos from TEA which are available for you through the end of the year. These are the Marilyn Burns videos which go with some of the manipulatives that we have been using. They do emphasize the use of manipulatives in the introduction of math concepts. The purpose of using manipulatives is to help children integrate abstract concepts through concrete applications... to be able to provide the meaning that they need to bridge the gap between the abstract and the concrete. It is my hope that through the use of manipulatives we will allow children to get into what I have referred to throughout this workshop as the "math mode".

For young children it is very difficult to reason abstractly; by the repetitive of manipulatives it becomes second nature for them to think in this manipulative manner across the bridge of abstract

to concrete and vice versa. It provides them with the repetition and the practice which enables them to form firm foundations for good understanding of math concepts and hopeful success for advanced future concepts and more demanding mathematical cognitive processes.

We have the Marilyn Burns learning kit with all of its different manipulatives. I really do urge you to take advantage of this. There is an overview of all six models which is 20 minutes long which serves as an introduction; while each individual learning manipulative model is a 20 minute video tape.

Thanks again. I really would appreciate it if you would fill out the evaluation sheet and put it in my box, along with any suggestions that you might have for ways to increase participation in mathematics problem-solving involving parents, community, teachers and students.

As you leave I have one final handout for you that I would like you to pick up as you go out the door. It is something that I found really thought provoking and I wanted to share it with you. Read it at your leisure and give it some thought. I think it is something that deserves attention.

HANDOUTS

# MATH IN THE JOB MARKET

## How much high school math is needed for a job?

The Math-Science Network through a grant from Chevron determined that one needs: at least two years of high school math beginning with one year of algebra to work as a:

| | | |
|---|---|---|
| police officer | dental assistant | fire fighter |
| carpenter | postal clerk | office clerk |
| bookkeeper | electrician | medical assistant |
| machinist | plumber | social worker |
| construction worker | data processor | |

at least three years of high school math beginning with one year of algebra to work as a:

| | | |
|---|---|---|
| teacher | dietician | nurse |
| draftsperson | photographer | pilot |
| horticulturalist | survey technician | sociologist |
| computer programmer | dental technician | mental health worker |
| forestry aide | medical secretary | home economist |
| X-ray technician | pharmacy assistant | computer technologist |

at least four years of high school math beginning with two years of algebra, one year of geometry, and a year of precalculus math to work as a:

| | | |
|---|---|---|
| physician | airline pilot | astronomer |
| engineer | geologist | chemist |
| dentist | forester | architect |
| computer scientist | biochemist | veterinarian |
| economist | political scientist | meteorologist |
| interior designer | graphic artist | pharmacist |

A student who earns a C grade in algebra and geometry has a better chance of succeeding in college than a student who avoids these subjects. Most present day jobs, and life in general, require a background in numerical and statistical data.

Even with four years of high school math it is still difficult to persuade high school students, especially women, to major in math, science, or engineering in college. Yet, a substantial number of people in these fields is necessary for the United States to maintain its competitive edge in the world. In a recent study conducted by the Educational Testing Service under a grant from the National Science Foundation, Jerilee Grandy found that in the past three to four years students have turned away from the sciences, even the top Math-SAT scoring students. In 1982, 50% of the top scoring students went on to major in math, science or engineering, whereas in 1986, only 44% of the top scoring students went on to major in these areas.

If the number of students majoring in the sciences and mathematics is to be increased and the underrepresentation of minorities and women in mathematics and the sciences is to be reversed, interest in such careers must be awakened and students must be motivated to select higher level courses in these fields before they enter high school.

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## The Best Jobs in America

*1. Actuary*
*2. Computer Programmer*
*3. Computer Systems Analyst*
*4. Mathematician*
*5. Statistician*
*6. Hospital Administrator*
*7. Industrial Engineer*
*8. Physicist*

Based on work environment, salary, projected growth, stress, security and physical demands.

9. Astrologer
10. Paralegal
11. Bank Officer
12. Movie Editor
13. Biologist
14. Technical/Copy Writer
15. Accountant
16. Civil Engineer
17. Print Editor
18. Pharmacist
19. Political Scientist
20. Astronomer
21. Aerospace Engineer
22. Broadcast Newswriter
23. Physiologist
24. Insurance Underwriter
25. Chemist
26. Librarian
27. Urban / Regional Planner
28. Medical Assistant
29. Sociologist
30. Medical Records Technician
31. Musical Instruments Repairer
32. Electrical Engineer
33. Broadcast Technician
34. Meteorologist
35. Nuclear Engineer
36. Petroleum Engineer
37. Employment Counselor
38. Chiropractor
39. Home Economist
40. Anthropologist
41. Federal Judge
42. Electrical Technician
43. Mechanical Engineer
44. Philosopher
45. Geologist
46. Lithographer / Photoengraver
47. Agricultural Scientist
48. Optometrist
49. Economist
50. Audiologist

Source: *The Jobs Rated Almanac*, Les Krantz, 1988

# Top Growth Occupations 1984-2000

Lawyers, Judges
+ 71%

Scientists, Computer Scientists, Mathematical Scientists
+ 68 %

Health Diagnosing and Treatment
+ 53%

Technicians
+ 44%

Source: *Workforce 2000*

# Workforce 2000

- The income-generating assets of a nation are the knowledge and skills of its workers.
- A century ago, a high school education was thought to be superfluous for factory workers and a college degree was the mark of an academic or a lawyer.
- In the 1990s a majority of all new jobs will require postsecondary education.
- Even the least skilled jobs will require a command of reading, computing, and thinking that was once necessary only for the professions.
- Education and training are the primary systems by which the human capital of a nation is preserved and increased.

**Integrating Blacks and Hispanics Fully into the Workforce**

For minority workers, the changes in the nation's demography and economy during the 1990s represent both a great risk and a great opportunity. With fewer new young workers entering the workforce, employers will be hungry for qualified people and more willing to offer jobs and training to those they have traditionally ignored. At the same time, however, the types of jobs being created by the economy will demand much higher levels of skill than the jobs that exist today. Minority workers are not only less likely to have had satisfactory schooling and on-the-job training, they may have language and attitude problems that prevent them from taking advantage of the jobs that will exist.

If the policies and employment patterns of the present continue, it is likely that the demographic opportunity of the 1990s will be missed and that, by the year 2000, the problems of minority unemployment, crime, and dependency will be worse than they are today. Without substantial adjustments, blacks and Hispanics will have a smaller fraction of the jobs of the year 2000 than they have today, while their share of those seeking work will have risen.

Each year of delay in seriously and successfully attacking this problem makes it more difficult. Not only will the jobs become more sophisticated and demanding, the numbers of new workers entering the workforce will begin to increase after 1993. Now is the time to renew the emphasis on education, training, and employment assistance for minorities that has been pursued with limited success over the past several decades. These investments will be needed, not only to insure that employers have a qualified workforce in the years after 2000, but finally to guarantee the equality of opportunity that has been America's great unfulfilled promise.

If new efforts to employ minority workers are to succeed where earlier efforts have failed, both individual attitudes and social institutions must change.

Traditional job training and employment programs by themselves are unlikely to have profound impacts on the future success of minority youth. Unless the $127 billion public educational system can somehow be better harnessed to serve minority youth, the $4 billion Job Training Partnership Act system can make only a small dent in the problem. For the public educational system to succeed with the minorities, however, may require radical changes. In school districts with the most serious problems, not only vouchers but complete privatization of the schools should be considered. Performance standards should be applied, not only to teachers but to students, administrators, and schools themselves. In practice, this might mean not only support for magnet schools that can be islands of excellence, but a willingness to close the worst schools, fire incompetent teachers, and expel disruptive students.

The complex interconnections between employment, education, literacy, cultural values, income and living environments argue that employment problems cannot be solved without also addressing issues of individual and family responsibility. The choices are not simply between on-the-job training and basic skills remediation programs for teenagers, but among investments in child care, pregnancy prevention, welfare reform, big brother programs, and other possible interventions. Before minority unemployment can be significantly reduced, there must be change in the cultural values that make it seem more attractive to sell drugs or get pregnant than to do well in school and work at McDonald's.

Private employers have a new, and more expensive, role to play in the development of their workforces. Not only are they critically affected by the quality of the workers they will hire over the next 13 years, they are among the most knowledgeable designers and implementers of cost-effective, technology-based training programs. If there are real breakthroughs in training and hiring young disadvantaged workers between now and the year 2000, "second chance" educational systems developed at the worksite are likely to play a key role.

## Improving Workers' Education and Skills

In previous centuries, the wealth of nations was thought to consist of gold in the national treasury and jewels in the emperor's crown. In more recent years, wealth has often been equated with factories, mines, and production machinery within a nation's borders.

As the miraculous rebirth of Europe and Japan after World War II has proven, however, the foundation of national wealth is really people—the human capital represented by their knowledge, skills, organizations, and motivations. Just as the primary assets of a modern corporation leave the workplace each night to go home for dinner, so the income-generating assets of a nation are the knowledge and skills of its workers—not its industrial plants or natural resources.

As the economies of developed nations move further into the post-industrial era, human capital plays an ever more important role in their progress. As the society becomes more complex, the amount of education and knowledge needed to make a productive contribution to the economy becomes greater. A century ago, a high school education was thought to be superfluous for factory workers and a college degree was the mark of an academic or a lawyer. Between now and the year 2000, for the first time in history, a majority of all new jobs will require postsecondary education. Many professions will require nearly a decade of study following high school, and even the least skilled jobs will require a command of reading, computing, and thinking that was once necessary only for the professions.

Education and training are the primary systems by which the human capital of a nation is preserved and increased. The speed and efficiency with which these education systems transmit knowledge govern the rate at which human capital can be developed. Even more than such closely-watched indicators as the rate of investment in plant and equipment, human capital formation plays a direct role in how fast the economy can grow.

If every child who reaches the age of seventeen between now and the year 2000 could read sophisticated materials, write clearly, speak articulately, and solve complex problems requiring algebra and statistics, the American economy could easily approach or exceed the 4 percent growth of the boom scenario. Unconstrained by shortages of competent, well-educated workers, American industry would be able to expand and develop as rapidly as world markets would allow. Boosted by the productivity of [a] well-qualified workforce, U.S.-based companies would reassert historic American leadership in old and new industries, and American workers would enjoy the rising standards of living they enjoyed in the 1950s and 1960s.

If this bright future is to be realized, the educational standards that have been established in the nation's schools must be raised dramatically. Put simply, students must go to school longer, study more, and pass more difficult tests covering more advanced subject matter. There is no excuse for vocational programs that "warehouse" students who perform poorly in academic subjects or for diplomas that register nothing more than years of school attendance. From an economic standpoint, higher standards in the schools are the equivalent of competitiveness internationally.

Preceding two pages excerpted from *Workforce 2000*, 1987, pages 114-117.

***ASSUMPTIONS***

The standards for teaching are based on four assumptions about the practice of mathematics teaching:

**1. *The goal of teaching mathematics is to help all students develop mathematical power.*** The *Curriculum and Evaluation Standards for School Mathematics* provide the basis for a curriculum in which mathematical reasoning, communication, problem solving, and connections are central. Teachers must help students develop conceptual and procedural understandings of number, operations, geometry, measurement, statistics, probability, functions, and algebra and the connections among ideas. They must engage students in formulating and solving a wide variety of problems, making conjectures and constructing arguments, validating solutions, and evaluating the reasonableness of mathematical claims. Along with all this, teachers must foster in students the disposition to use and engage in mathematics, a valuing of its beauty and utility, and a tolerance for being stuck that enables them to persevere when confronted with a puzzling problem, and the self-confidence and interest to do so.

**2. *<u>What</u> students learn is fundamentally connected with <u>how</u> they learn it.*** Students' opportunities to learn mathematics are a function of the setting and the kinds of tasks and discourse in which they participate. What students learn--about particular concepts and

PROFESSIONAL STANDARDS FOR TEACHING MATHEMATICS, pages 10-11, Published by The National Council of Teachers of Mathematics.

procedures as well as about thinking mathematically--depends upon the ways in which they engage in mathematical activity in their classrooms. Their dispositions toward mathematics are also shaped by such experiences. Consequently, the goal of developing students' mathematical power requires careful attention to pedagogy as well as to curriculum.

3. ***All students can learn to think mathematically.*** The goals described in the *Curriculum and Evaluation Standards for School Mathematics* are goals for all students. Goals such as learning to make conjectures, to argue about mathematics using mathematical evidence, to formulate and solve problems--even perplexing ones, and to make sense of mathematical ideas are not just for some group thought to be "bright" or "mathematically able." The classrooms and students that appear in the vignettes included in this section are heterogeneous; the students are "regular kids," representing a typical range of mathematics achievement.

4. ***Teaching is a complex practice and, hence, not reducible to recipes or prescriptions.*** First of all, teaching mathematics draws on knowledge from several domains: knowledge of mathematics, of diverse learners, of how students learn mathematics, of the contexts of classroom, school, and society. Such knowledge is general. Teachers, however, must also consider the particular, for teaching is context-specific. Knowledge about adolescents in general, for instance, can only partly inform a decision about particular students learning a particular mathematical concept in a given context. Second, as teachers weave together knowledge from these different domains to decide how to respond to a student's question, how to represent a particular mathematical idea, how long to pursue the discussion of a problem, or what task to use to engage students in a new topic, they often find themselves having to balance multiple goals and considerations. Making these decisions depends on a variety of factors that cannot be determined in the abstract nor governed by rules of thumb.

Because teaching mathematics well is a complex endeavor, it cannot be reduced to recipes for helping students learn. Instead, good teaching depends on a host of considerations and understandings. Such teaching demands that teachers reason about pedagogy in professionally defensible ways within the particular contexts of their own work. The standards for teaching mathematics are designed to help guide the processes of such reasoning, pointing to issues that are crucial in creating the kind of teaching practice that supports the learning goals of the *Curriculum and Evaluation Standards for School Mathematics*.

PROFESSIONAL STANDARDS FOR TEACHING MATHEMATICS, PAGES 10-11, Published by The National Council of Teachers of Mathematics.



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## Domain I. Instructional Strategies

**Criterion 1. provides opportunities for students to participate actively and successfully.**

| Performance Indicators | Explanations/Examples |
|---|---|
| a. appropriately varies activities | a. Students participate actively in problem-solving lessons. Teachers present a variety of problems with more than one strategy to find a solution. |
| b. interacts with students in group formats as appropriate | b. Group work is a characteristic of good problem-solving lessons. |
| c. solicits student participation | c. Because problem-solving lessons are intrinsically interesting, and because students usually work in groups, student participation should be high. |
| d. extends students' responses/contributions | d. Teachers should be asking students to elaborate or provide other information, and extending by asking them why they used particular strategies and which strategies worked best. |



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| | |
|---|---|
| e. provides ample time for students to respond | e. Teachers should have many opportunities to demonstrate wait-time during problem-solving lessons. |
| f. implements instruction at an appropriate level of difficulty. | f. Students should have manipulatives. No computations above the students' ability should be required. |

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**Domain I: Instructional Strategies**

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**Criterion 2. evaluates and provides feedback on student progress during instruction**

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| Performance Indicators | Explanation/Examples |
|---|---|
| a. communicates learning expectations | a. Teachers will communicate objectives at the <u>end</u> of the lesson. |
| b. monitors students' performance as they engage in learning activities | b. Teachers should monitor student performance by asking process questions that have students explain their thinking processes during problem solving. |

Performance indicators c, d, e, and f under this criterion will function as they do in direct instruction.

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**Domain II: Classroom Management and Organization**

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All Performance Indicators in this Domain will function as they do in direct instruction lessons. Performance Indicators in this Domain that may provide opportunities to award EQs are as follows.

Criterion 3. organizes materials and students

a. secures student attention, or students are attending. The intrinsically interesting nature of problem-solving lessons should provide high levels of interest and attention.

d. maintains seating arrangement/grouping appropriate for the activity and the environment. Grouping is a frequent characteristic of problem-solving lessons.

Criterion 4. maximizes amount of time available for instruction

e. keeps students engaged. Again, if teachers present appropriate problems and encourage students to try a variety of strategies to solve, the students should exhibit very high engagement rates (in excess of 85%).

Performance Indicators that teachers should be especially aware of in this Domain are as follows.

Criterion 3, PI e. has materials, aids, and facilities ready for use

Teachers must have all manipulatives and other support ready, or at least available, before beginning a problem-solving lesson.

Criterion 5, PI c. uses techniques to redirect/stop inappropriate/disruptive behavior, or none needed

Because many problem-solving activities are done in groups, the potential for disruption (two or more students violating a standard or interfering with others' ability to learn ) may be higher.

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**Domain III: Presentation of Subject Matter**

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**Criterion 6. teachers for cognitive, affective, and/or psychomotor learning**

| Performance Indicator | Explanation/Examples |
|---|---|
| a. begins instruction/activity with an appropriate introduction. | a. Same as for direct instruction. |
| b. presents information in an appropriate sequence | b. The sequence for problem solving is that of inductive reasoning. Students should gain an even greater understanding of the relation of the parts to the whole. |

**Performance Indicators c-h should function the same as in a direct instruction lesson.**

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**Criterion 7. uses effective communication skills**

**All Performance Indicators in Criterion 7 should function the same as in direct instruction lessons.**

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**Domain IV: Learning Environment**

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**All Performance Indicators under Criteria 8 and 9 in this Domain should function as they do in direct instruction lessons. In fact, this Domain should provide excellent opportunities to award EQs, as the Performance Indicators in this Domain are all crucial to successful problem-solving lessons.**

## SAMPLE ACTIVITIES TO INCREASE PARTICIPATION IN MATHEMATICS PROBLEM SOLVING

### Supportive Interactions for Parent/Community Involvement

___1. Involve students, families, and community in purchasing, making, and/or collecting manipulatives
- ___a. Coordinate with a Math/Science Alliance and/or Adopt-A-School project
- ___b. "junk" collection campaign
- ___c. recycling to raise money
- ___d. family night for making materials
- ___e. community time for making materials

___2. Include math announcements in the parent newsletter.

___3. Provide brief notes to parents that keep them updated on the "new" activities (calculator use, manipulatives, instructional games)

___4. Request support from parent/community groups for teachers to attend conferences.

___5. Schedule family information sessions about new developments in the math program.
- ___b. working with manipulatives
- ___c. problem solving
- ___d. calculator use

___5. Encourage and support teachers to attend math conferences, at the local, regional, state, and national levels.

___a. approach parent and industry groups to provide - support.

___b. schedule follow-up presentations and/or sharing sessions.

___6. Institute a school math group with the responsibility for reviewing and recommending manipulative materials, media sources, and resource books to be purchased.

___7. Hold a math fair in the school. (Have teachers prepare during the year by scheduling approapriate activities as part of regular instruction.)

___8. Generate a list/collection of enrichment activities, guest speakers (careers), and field trips with a math component.

___9. Increase the "Public Relations" (PR) for Math in your school

___a. posters

___b. problem-of-the-day

___c. bulletin boards

___d. instructional TV (Square One)

___e. use of videos

## SAMPLE ACTIVITIES TO INCREASE PARTICIPATION IN MATHEMATICS PROBLEM SOLVING

Supportive Interactions for Teachers and School Program

___1. Order Arithmetic Teacher/Mathematics Teacher and other professional journals for the school.
- ___a. rotate journals among teachers and discuss specific articles at faculty meetings.
- ___b. provide copies of important articles to teachers.

___2. Designate a primary/intermediate/grade level person as the "Key Communicator" in mathematics. These teachers may be responsible for directing math info to others, may receive more inservice in math and then provide sessions at the school level.

___3. Encourage and support teachers to attend inservice training sessions.
- ___a. let the teachers know that they are appreciated-lunches by parent groups, T shirts, thank-you notes, etc.
- ___b. provide ways to display teachers' TEA certificates.
- ___c. schedule follow-up sessions for sharing.

___4. Provide opportunities for in-school inservice sessions.
- ___a. discuss the use of cooperative groups in problem solving.
- ___b. discuss the use of specific manipulative materials.
- ___c. discuss the use of problem-solving bulletin boards, learning centers, etc.
- ___d. discuss the use of writing in the math classroom.
- ___e. discuss the use of the TTAS Performance Indicators during problem-solving lessons.



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## Outline For A Successful Math Lesson

- Secure student attention with an anticipatory set. (Remember students are interested in themselves, family, pets, friends, T.V programs, food,...etc.)

- Make a statement concerning what the students learned in the previous math lesson. (Review)

- State the objective of the lesson. (Explain in your own words what the objective means.)

- State your expectations. (At the end end of the lesson I expect you to be able to ....)

- Explain the agenda of the lesson. (Tell the students what they will do to accomplish the expectation.) Example: "We are going to use unifix cubes, work five problems cooperatively and check them, make up word problems, individually, and do the odd numbered problems on page 102."

- State the value of the lesson. (Ask the students why they need to learn the skill.)

- State how this skill can be applied to real life situations. (This might come out during the discussion of the value of the lesson.) The skill can be applied during the lesson most of the time, but if you talk about it and do it, it is even better. Example: The word problems are application of the skill - practice is not application.

- Restate the objective and begin input. (Direct instruction with student participation should be at least 20-25 minutes.)

- Check for understanding as you give input and by giving not more than five problems to work and check. (This could also be called your guided practice - the teacher will help individual students while others are working the problems.)

- Give each student the assignment to write two word problems using the newly acquired skill. (Share some or all of the problems. You do not have to work them all, but talk about how you would solve them.)

- Have the students work the odd numbered problems on page ____. (This is independent practice.)

- Close the lesson by reviewing what the students have learned. (This may be done before or after the independent practice is assigned.)

AUSTIN INDEPENDENT SCHOOL DISTRICT, Office of Elementary Education.

TRANSPARENCIES

# Types of Careers Involving Mathematics

Computer Sciences

Engineering

Actuary

Statistics

Sciences

Mathematical Research

Education

# The Best Jobs in America

*1. Actuary*

*2. Computer Programmer*

*3. Computer Systems Analyst*

*4. Mathematician*

*5. Statistician*

*6. Hospital Administrator*

*7. Industrial Engineer*

*8. Physicist*

Source: *The Jobs Rated Almanac*

# Top Growth Occupations 1984-2000

Lawyers, Judges
+ 71%

Scientists, Computer Scientists, Mathematical Scientists
+ 68 %

Health Diagnosing and Treatment
+ 53%

Technicians
+ 44%

Source: *Workforce 2000*

# Workforce 2000

- The income-generating assets of a nation are the knowledge and skills of its workers.
- A century ago, a high school education was thought to be superfluous for factory workers and a college degree was the mark of an academic or a lawyer.
- In the 1990s a majority of all new jobs will require postsecondary education.
- Even the least skilled jobs will require a command of reading, computing, and thinking that was once necessary only for the professions.
- Education and training are the primary systems by which the human capital of a nation is preserved and increased.

If (our) bright future is to be realized,
students must

**go to school longer,**
**study more**, and
**pass more difficult tests**
covering more advanced subject matter.

Source: *Workforce 2000*

# IMPACT OF TECHNOLOGY ON THE MATHEMATICS CURRICULUM

- Some mathematics becomes **more important** because technology **requires** it.

- Some mathematics becomes **less important** because technology **replaces** it.

- Some mathematics becomes **possible** because technology **allows** it.

What would you rather have--

your height in stacked nickels

or

in quarters laid end to end?

Eight primary teachers from Polya Elementary School attended a problem-solving inservice (for Advanced Academic Training credit, of course.) If each teacher was paired with every other teacher for problem-solving teams, how many pairings were there?

IN JOHN'S BOX IS AN AWFULLY UNUSUAL GROUP OF WORDS. CAN YOU FORM AN OPINION ON WHY SUCH A BUNCH OF WORDS IS SO UNCOMMON?
JOHN

## Getting Your Money's Worth

| | |
|---|---|
| A = $.01 | N = $.14 |
| B = $.02 | O = $.15 |
| C = $.03 | P = $.16 |
| D = $.04 | Q = $.17 |
| E = $.05 | R = $.18 |
| F = $.06 | S = $.19 |
| G = $.07 | T = $.20 |
| H = $.08 | U = $.21 |
| I = $.09 | V = $.22 |
| J = $.10 | W = $.23 |
| K = $.11 | X = $.24 |
| L = $.12 | Y = $.25 |
| M = $.13 | Z = $.26 |

Coming down a hill covered with snow are two ski tracks- one on either side of a tree. Draw a sketch and give several explanations that fit these facts.

## OPPORTUNITIES FOR TEACHERS

**Provide children with a mathematical foundation for problem solving by:**

- **modeling a positive attitude**
- **providing a variety of problem-solving experiences**
- **being a problem solver**



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| | |
|---|---|
| e. provides ample time for students to respond | e. Teachers should have many opportunities to demonstrate wait-time during problem-solving lessons. |
| f. implements instruction at an appropriate level of difficulty. | f. Students should have manipulatives. No computations above the students' ability should be required. |

Domain I: Instructional Strategies

Criterion 2. evaluates and provides feedback on student progress during instruction

| Performance Indicators | Explanation/Examples |
|---|---|
| a. communicates learning expectations | a. Teachers will communicate objectives at the <u>end</u> of the lesson. |
| b. monitors students' performance as they engage in learning activities | b. Teachers should monitor student performance by asking process questions that have students explain their thinking processes during problem solving. |

Performance indicators c, d, e, and f under this criterion will function as they do in direct instruction.

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**Domain II: Classroom Management and Organization**

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**Domain III: Presentation of Subject Matter**

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**Performance Indicators c-h should function the same as in a direct instruction lesson.**

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**Domain IV: Learning Environment**

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